The Clinical advantages of Ozone and its Effects on the Micro-Organisms of Infusions.

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The conclusions arrived at by Dr. Cornelius B. Fox in his work on Ozone, he summarized as follows: "1. A deficiency of ozone in the air in all probability predisposes to disease, particularly in the epidemic form, by virtue of the depressing and debilitating effect of such air in consequence of its feeble power of oxidizing animal débris. 2. A permanent diminution in the normal amount of active oxygen favors the development of chronic diseases characterized by malnutrition, imperfect oxidation, and degeneration of tissues."

These are the statements of a gentleman who has produced one of the most complete works on ozone to the present time. The "in all probability" clause indicates the uncertainty existing as to the value and exact operation of ozone in its relation to health and disease. The theory now so prevalent regarding the etiology of the so-called zymotic diseases did not exist when Dr. Fox wrote these words with the force it does to-day. It is only within a few years that the intimate relations existing between the minute forms of animal and vegetable life and many of the most serious diseases have been known. It is true that physicians of former periods have held such views, but it has been left to the microscopists of our immediate time to demonstrate this intimacy. If we hold this opinion, that the ills in question are produced through the agency of the micro-organisms which gain access to the system when it is in a condition suitable for their propogation, we will be

ready to appreciate the value of the agent which can be practically applied in the arrest or modification of their virulency in their development. Many of our ablest physicians have accepted the germ theory of diseases as among the discoveries of the past, and with this belief investigations have been extensively made for the purpose of discovering such an agent. As to the value of ozone as a germicide very little can be said. So far as I am acquainted it appears that a sufficiently concentrated ozonized atmosphere retards the movements of the bacteria, and this may indicate its effect on germs or spores. Whether the most effective agent we may discover in the future will be a germicide is of little consequence. Such agent may work through its modifying influence on the spores, the organisms themselves or their envirment to produce the desired effect.

Among those who have given considerable attention to the use of ozone in the clinical treatment of disease, and whose investigations have extended over a sufficient period of time to make them valu able, may be mentioned Dr. F. W. Bartlett, of Buffalo, N. Y., who, in October, 1875, read a paper before the medical and surgical association of that city entitled the "Practical Utilization of Ozone in the Treatment of Disease." In that paper he presented the reports of forty cases treated in air modified by ozone, and claimed remarkably successful results in cases of peculiar severity. In June, this year, he read another paper with the same title, and stated that nearly seven years had elapsed and he had in that time used the ozone in some two thousand cases, in diseases of an essentially zymotic character. These diseases embraced scarlet fever, diphtheria, whooping-cough, typhoid and malarial fever, phthisis, hay fever measles, dysentery, influenza, pneumonia, etc. In most of the cases satisfactory results were noticed. In these cases the ozone was generated from phosphorus placed in a moist atmosphere, the apparatus used being conveniently adapted to this method of producing ozone. In these cases the atmosphere had not been surcharged, if this were possible by this method of generation, so as to make respiration difficult. For the purpose of making you acquainted with the method Dr. Bartlett pursued, I will cite one or two typical cases. "A child of Mr. G. M. Butler, in 1876, born

with a bright scarlatinal rash. I immediately placed it in a strongly ozonized atmosphere, with no expectation of a favorable result, as such cases invariably die. The child, however, kept up a diaphragmatic jerk for thirty-six hours, when regular respiration was established, and it recovered with the usual desquamation and no sequelæ. An older child had been under treatment for two weeks in ordinary atmosphere, and had a tedious convalescence with cervical swellings and otitis. No medicine was given the case first cited." An illustration of the apparent value of ozone in limiting the spread of disease is given in the following case:

"Mrs. B. had a child aged 7 years, taken ill August, 1878, with scarlatina maligna. Six other children were similarly exposed. The residence was an ordinary small, one-story cottage, containing five rooms, two being bed-rooms. In one of these the child was placed with special ozone generator, and a generator was also placed in the dining-room adjoining the bed-rooms. The children were confined to the front room except at meal time, when, the door of the sick-room being closed they took their meals in the dining-room. With these precautions, all escaped the disease and the patient made a good recovery. Mr. H. had a child taken with scarlet fever, in the summer of 1879; directed isolation in upper front room of two-story house, mother to nurse, and no one else to be admitted to the room; ozone used; child recovered. No other cases. Two years later, disease appeared in same family,—medical attendant not known to me,—and three patients, about two, eleven, and eighteen years of age, died." Dr. Bartlett stated that he could go on for hours with reports of cases successfully treated with ozonized air.

It is not my purpose to uphold or condemn Dr. Bartlett's views. I have not had opportunity to make similar experiments. I am compelled to cite them as I know of no one who has made such an extended clinical application of ozone. We can not listen to statements similar to the foregoing from any respectable physician without at least being interested in the work he is engaged in. The general effects of the ozone treatment were summed up as follows: In diphtheria liquefaction takes place promptly, the fetor is almost entirely suppressed, and in mild cases the exudate usually disappears by the third day. As a rule there is no secondary return. In

scarlet fever the object is to change the atmosphere as fully as possible, thereby affording an outlet to the poison through the cutaneous surface. In whooping cough the results are stated to be in many cases truly surprising and beneficial. In hay fever the results are favorable. In dysentery results favorable. In croup no certain advantage. In a few cases of puerperal fever marked benefit and recovery. Patients with phthisis pulmonalis, marked benefit, cough, diarrhœa and perspiration favorably modified. The cases observed were, however, in advanced stages. In senile gangrene, useful as a disinfectant. In resisting the return of disease it is very valuable in cases of typhoid fever and diphtheria, and in scarlatina and scarlet fever it appears to modify the severity of the disease. He states that he has seen a case of malignant scarlet fever fatal in thirty-six hours, the child rolling in convulsions in its liquid excrement, succeeded in forty-eight hours by a second case of the same nature, but perfectly amenable to treatment, though the disease was prolonged for weeks, and a third case in the same family so slightly ill as to call for no treatment, and the fourth and youngest escaped altogether.

The observations made by myself in connection with this subject were begun March 23, 1883, and continued as opportunity permitted to the present time, I am unaware whether similar observations have been made heretofore. As to the results, I have nothing to say further than that in some instances the ozonized atmosphere appeared to have a marked effect on the life in the infusions, and in others no variation from the ordinary conditions were noticeable. The examinations were made with a 1-16 inch so-called objective of Gundlach and with a one-inch eye-piece—a power of about 1,200 diameters, and with a $\frac{1}{8}$-inch homogenous immersion of Bausch and Lomb. The first experiment consisted in subjecting a sample of urine found to be teeming with life to the ozonized atmosphere. No change appeared to ensue in the growth, movements, or appearance of the life in such infusion as compared with a portion of the same exposed to the ordinary atmosphere. April 5, 1883, infusions of cod and scallops were prepared, filtered, placed in test-tubes, and boiled actively for some time for the purpose of destroying the spores which might be existing in them. Cohn concluded "that

while hay infusions are generally sterilized by a temperature of 140 or more degrees Fah., prolonged during twenty-four hours, certain spores of bacillus seem able to endure a temperature of 158 to 170 degrees Fah. during three or four days without loosing their power of germinating." From this it would appear that subjection to a temperature of 212 degrees Fah. for ten or fifteen minutes would sterilize such infusions. * Tyndall in his celebrated experiments sterilized them by boiling a longer or shorter period. One test tube partially filled with the infusions was placed in an ozonized atmosphere and another of the same infusion exposed to the ordinary atmosphere in rooms of about the same temperature, and in other respects under nearly similar conditions. In some instances one of the small ozone machines was in use, at other times two. The question as to whether positive results would have followed from the use of a more concentrated ozonized atmosphere remains open for consideration. Whether small chambers of entirely ozonized atmosphere, separate from the surrounding atmosphere for a time, would give different results, I have not yet had an opportunity of determining. The weather was quite cold during these observations, consequently the development in the infusions was not so rapid as would otherwise have been the case. The following tables show the result of experiments:

* The variation if any, in the life in the infusions is the important element in the investigations. The question of sterility is not important in this connection.

Name of infusion and date prepared.	Time of exposure to ordinary atmosphere.	Ordinary atmosphere. Results of examinations.	Time of exposure to ozonized atmosphere.	Ozonized atmosphere. Results of examination.	Remarks.
	h. m.		h. m.		
Codfish—	10.30	No indications of life.	10.30	No indications of life.	Examination made at 8 A. M. April 6, 1883.
(Apr. 5, 9.30 P.M.)	41.30	Spores sparsely scattered throughout slide. Two or three bacteria moving about in field.		No corresponding examination.	Examination April 7, 3 P. M.
Cod—	61.45	Well supplied with life. Spherical and rod-like forms in *torula* stage and also *leptothrix* stage, throughout field. Forms in active motion. Cloudy to eye. (Examination Apr. 8, '83, at 11.15 A. M.)	64.10	But one rod-like form and two or three spherical bacteria noticed in field. No active movement. (Examination April 8, '83, at 1.50 P. M.)	
Cod—	96.40	Life plentiful throughout field; motion active. Examination April 10, (1883, at 12.45 A. M.)	96.45	Large spore-like bodies throughout field. No motion observed. (Examination April 10, 1883, at 12.50 A. M.	Marked contrast.
Cod—	132.30	Field covered with multitudes of micrococci, *zoogloea* stage. (Examination April 11, 1883, A. M.)	132.50	Field well supplied with micrococci, *torula* stage. Numbers much less than in unozonized infusion. (Examination April 11, 1883, at 8.20 A. M.)	
Halibut— (April 6, 1883, 7 P. M.)	41.00	Many bacteria, spherical, spiral, and rod-like forms in active motion. Infusion clear to eye. Examination April 8, 1883, 12 M.	43.40	Spirillæ in good numbers, but not so great as in unozonized infusion. Active motion. Spherical forms noticed plentifully in unozonized infusion not seen in this. To eye clear and pellucid. Examination April 8, '83. 2.40 P. M.	
Halibut—	65.00	Hundreds of bacterial forms moving throughout field. Also same immotile all over field. Examination April 8, '83, 12 midnight.	64.55	But two motile bacterium in field. Examination April 9, 11.55 P. M.	Marked contrast.
Halibut—	114.30	Field fully covered by bacteria in active motion. Examination April 11, 10:30 P. M.	114.40	Similar conditions, numbers not so great. Examination April 11, 10.40 P. M.	
Trout— (April 6, 1883, 7 P. M.)	40.45	One motile bacterium in field Infusion clear and pellucid. Examination April 8, '83, 11:45 A. M.	40.48	Similar to last—viz: Clear, pellucid, but no motile forms in view. Examination April 8, 1883, 11.48 A. M.	
Trout—	53.10	Two or three rod-like forms in field. Several spherical (torula) forms and minute sporule-like forms distributed throughout field. Examination April 9, '83, 12:10 A. M.	53.15	Similar, as near as could be judged, to unozonized infusion. Examination April 9, '83, 12.15 A. M.	
Trout—	123.10	Bacteria plentiful in field. Active motion, some forms darting across field, others wriggling along. Examination April 11, 1883, 10:10 P. M.	123.15	Similar forms in different stages of development, but not so active. Forms less numerous than in unorganized infusion. Examination April 11, '83, 10.15 P. M.	

Name of infusion and date prepared.	Time of exposure to ordinary atmosphere.	Ordinary atmosphere. Results of examinations.	Time of exposure to ozonized atmosphere.	Ozonized atmosphere. Results of examinations.	Remarks.
Salmon— (Apr. 6, 1883, 7 P. M.)	h. m. 60.40	Many very minute, spore-like bodies, spherical, motionless. One or two very minute forms moving about. Examination April 8, '83, 12.40 P. M.	h. m. 61.45	A number of sporule-like forms to be seen. No motion in field. Examination April 8, '83, 1.45 P. M.	
Salmon—	76.40	A few small, rod-like forms in motion. Clear and transparent. Examination April 9, '83, 11.45 P. M.	76.45	But one bacterial form in field. A chain of six spherical bodies without motion observed. Examination April 6, '83, 11.45 P. M.	
Salmon—	99 45	Micrococci and bacteria in active motion throughout field. Examination April 11, '83, 10.45 P. M.	99.49	Very few forms in field. All noticed were micrococci. Examination April 11, '83, 10.49 P. M.	
Scallops— (April 5, 9.30 P. M.	10.30	No indications of life. Examination April 6, '83, 8 A. M.	10.30	No indications of life. Examination April 6, '83, 8 A. M.	
Scallops—	62.00	A few squamous particles in same. No life apparent. One or two sporule-like forms visible. No motion. Clear to eye. Examination April 8, '83, 11:30 A. M.	62.10	Sporule-like forms noticed. No active life. In other respects similar to unozoned infusion. Examination April 8, 83, 1.40 P. M.	
Scallops—	98.55	Micrococi torula stage abundant. Active motion throughout whole field. Examination April 10, '83, 12.25 A. M.	99.15	Immotile spore-like bodies highly rafractive, with bacterial forms in motion. Examination April 10, '83, 12.45 A. M.	
Scallops—	144.30	Micrococci in small numbers moving about field. Examination April 11, '83, 10 P. M.	144.50	Bacteria in active motion fill field. Micrococci in small numbers. Examination April 11, '83, 10.20 P. M.	
Mutton— (April 6, 1883, 7 P. M.)	42.00	This infusion prepared March 24, '83. March 30 was teeming with llfe. Reboiled before placing in test tubes. One or two moving bacterium. Examination April 8, '83, 1 P. M.	42.00	Ozonized preparation presented similar effect. Experiment April 8. '83, 1 P. M.	
Mutton—	76.45	Rodlike forms throughout field in active motion. To eye infusion clear and transparent: spherical bodies; no motion, all over field. Examination April 9, '83, 11.15 P. M.	77.00	But two rod-like forms to be seen. Rod-like forms active. No spherical bodies to be seen. Experiment April 8, '83, 11.30 P. M.	Marked contrast.
Mutton—	123.55	Minute bacterial forms with little motion in mycodermal stage. Experiment April 11, '83, 10.55 P. M.	12.45	Minute spherical forms few in number. One or two rod-like forms in field. Experiment April 11, '83, 11.10 P. M.	A marked contrast in the appearance of these infusions.

The object in making these observations was simply to note the effect if any on the life in the infusions. If ozone or any other agent in *respirable quantities* should be found to affect the development of these organisms, it would be an interesting fact to record. I am aware that so limited a number of observations would bear but lightly on the question, and understanding somewhat the peculiar conditions surrounding the propogation of these organisms, am not prepared to state that these differences recorded in the tables are produced by the ozone.

The following observations as to the odor and appearance of the several infusions, were made with the results recorded below. The time of examination is given. The infusions were prepared at the time given in the preceding tables:

Time of Examination.	Exposed to ordinary Atmosphere.	Exposed to Ozoned Atmosphere.
Mutton—	Odor, Slight.	Odor, none.
(April 14, 1883, 9:30 P. M.)	Hazy in appearance.	Simiiar in appearance.
Salmon—	Opaque, milky in appearance. Odor	Clear and pellucid.
(April 14, 1883, 9:32 P. M.)	very disagreeable.	Odor not preceptible.
Trout—	Odor noticeable.	Odor, none.
(April 14, 1883, 9:34 P. M.)	Pellucid.	Pellucid.
Scallops—	Pellucid.	Milky.
(April 14, 1883, 9:35 P. M.)	No odor.	No odor.
Halibut—	Odor marked.	Odor noticeable.
(April 14, 1883, 9:40 P. M.)	Pellucid.	Pellucid.
Cod—	Opaque, milky.	Pellucid, milky.
(April 14, 1883, 9:42 P. M.)	Odor exceedingly disagreeable.	Odor just perceptible.

May 28, 10 P. M., the following experiments were made: Remnants of cod, halibut, and trout infusions, which were allowed to stand several days exposed in open dishes to the atmosphere, gave off a remarkably unpleasant odor. They were mixed thoroughly, placed in an open dish, and subjected at 10 o'clock in the evening to the atmosphere of an aquarium, minus the water, which was ozonized by two of the small machines. In addition to this, pieces

of the same fish, which had become putrid were likewise placed in the aquarium. This valuable collection truthfully gave to the room an odor which can be likened to that of rotten fish, and was most unbearable. Being called up at 4 A. M. it was ascertained that the odor had been overcome and was not perceptible in the room. A good whiff at the aquarium revealed it. At 8 A. M. similar results were noted.

April 23, 10:30 P. M.—Prepared a thin solution of starch water. Allowed to stand until sediment gathered at the bottom of the vessels. The supernatent fluid was poured off several times and boiled in a test tube for a few minutes until the starch was thoroughly dissolved and the liquid quite clear. A small quantity of prepared yeast was then added. A portion of this liquid was then subjected to the ozonized atmosphere, and another portion to the ordinary atmosphere. Examination at different times failed to reveal any retardation or modification of the growth of the torula cerevisiæ which, after a time, plentifully filled both vessels.

April 12, 1883. 11:45 P. M.—At this time an infusion of codfish, prepared April 5, was covered by a thick scum, and teeming with life. Filter paper was saturated with the infusion and cut into three pieces. One piece was placed in the dome of the ozone apparatus, another on the outside of the same, the third was hung up in the ordinary atmosphere.

April 13, 9:30 P. M.—These pieces were examined by aid of a drop or two of water upon the slide and with the following results: The first, from the dome of the apparatus, was well supplied with motile bacteria. The second, from the exterior of the ozone generator, had very few active bacterial forms; while the third piece, dried for some twenty-four hours in the atmosphere of a room some distance from the former, was found much more plentifully supplied with life than the other pieces. In addition to these experiments, infusions of mutton, veal, and beef were examined, as in the case of the first infusions, with very similar results. There are many experiments which might be carried out in connection with such inquiries, which might possibly give more positive results. I have not had time to engage in them, and present these with regrets that they could not have been more thorough.